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ABSTRACT

A study of third-year medical school discussion groups was undertaken to determine how much the cognitive level of instructors' questions in small group sessions influenced student responses and whether these responses had any measureable relationship to critical thinking skills, or National Board of Medical Examiner (NBME) scores. The research model was based on concepts of process-outcomes designs, and the emphasis was to relate the verbal participation of the individual student to certain outcomes thought to be important to students in clinical training. The study sample consisted of 110 third-year medical students and 22 medical faculty. Students were assessed using the Medical College Admission Test, NBME preclinical performance appraisal, the Watson Glaser Critical Thinking Appraisal Test A, and three scales of the California Personality Inventory. The observational tool for the process measures was a modified version of the Flanders System of Interaction Analysis. Both teacher questions and student discussion incorporated the cognitive levels of Bloom's taxonomy. Two major study findings were: (1) the cognitive level of the teacher's questions was significantly correlated with the cognitive level of the individual student's response, particularly at the higher cognitive levels of analysis (synthesis and evaluation); and (2) the student's entry characteristics had a far larger effect on outcome measures than did the process of talk variables in the small discussion groups. (SW)

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VERBAL PARTICIPATION AND OUTCOMES IN MEDICAL EDUCATION

A Study of Third Year Clinical Discussion Groups

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VERBAL PARTICIPATION AND OUTCOMES IN MEDICAL EDUCATION
A Study of Third Year Clinical Discussion Groups

by
Patricia Joan Foster, Ph.D.

Introduction

Clinical teaching of medical students takes place in such varied situations as lecture halls, at the patient's bedside, and in small discussions with clinical instructors. Since the ultimate goal of clinical instruction is clinical problem solving (Elstein, Shulman, and Sprafka, 1978), considerable effort is (or should be) directed toward improving critical thinking skills. One assumes that this would most likely take place in the small group where there is close contact between teacher and student. There are few studies of what actually transpires in clinical teaching situations and none of these have related the classroom (or small group) activities to student outcomes. Throughout all levels of education there has been considerable discussion of how "what the teacher does" relates to "how the student performs." These "process-outcome" studies are complex and require careful statistical analysis.

The purpose of the present study was:

1. to see how much the cognitive level of instructors' questions in small group sessions influenced third year medical students' responses and
2. whether these responses had any measurable relationship to critical thinking skills, and National Board of Medical Examiner scores when the influence of certain student input characteristics had been considered.

Review of the Literature

It is intuitively attractive that the more actively the student participates in his learning the more effective that learning will be. The few well designed studies in this area support this concept (Bloom, 1976; Hecht, 1976; McKeachie and Kulik, 1975; Murray, 1977), but the investigator found no published reports at any level of education that related the amount or quality of the individual student's classroom verbal participation directly to student cognitive and affective outcomes.

The cognitive level of any verbal communication has been classified by Bloom (1956) according to the amount of integrative function required by the individual to process the information. A simple presentation of facts ("knowledge") is the lowest of the six cognitive levels. "Comprehension" of what these facts mean and their "application" to specific situations require more complex integration of information. The "higher cognitive levels" of "analysis," "synthesis," and "evaluation" require even more sophisticated integration of the factual information to the particular situation under discussion.

The cognitive level of teacher questions and student response both in college and medical school classes is generally at the lowest cognitive level of "knowledge" (Jason, 1962; Barnes, 1975; Foley, Smilansky and Yonke, 1977). Arnold, Atwood and Rogers (1974) demonstrated that with a minimum of training in the use of Bloom's taxonomy, teachers can raise the level of cognitive functioning in their classrooms. Other studies have shown that students tend to respond at the same cognitive level as the teacher's questions (Davis and Tinsley, 1968; Wood, 1970). Correlational and experimental

studies relating the cognitive level of teacher questions to student outcomes show no clear relationship between student achievement and the frequency with which the teacher uses higher cognitive questions (Dunkin and Biddle, 1974; Rosenshine, 1977; Winne, 1977, 1978).

Research on the student's learning process and educational environment in medical school has largely been directed toward:

1. Problems related to the transition from premedical to medical training and from preclinical to clinical education (Baird, 1975; Boyle and Combs, 1971; Coburn and Jovaisas, 1975; Donovan, Salzman and Allen, 1969; Haley and Lerner, 1972; Roessler, Butler, Rankin and Collins, 1978; Rosenberg, 1971).
2. The prediction of success in medical school from the characteristics of prospective students (Gough, 1964, 1971, 1978; Gough and Hall, 1975; Manaster and Friedman, 1976; Murden, Galloway, Reid and Colwill, 1978; Price, et al, 1971; Rothman, 1973; Wingard and Williamson, 1973).
3. Personality characteristics and attitudes of medical students (Adsett, 1968; Cliff and Cliff, 1972; Gough and Hall, 1973; Haley, D'Costa and Schafer, 1971; Juan, Gagan and Haley, 1974; McGuire, 1966; Perricone, 1974).
4. The impact of medical school of attitudes and values (Coe, Pepper and Mattus, 1977; Eron, 1958; Gordon and Mersh, 1962; Retzler, 1974; Rosinski, 1963).
5. The socialization of medical students within the medical school (Becker, Geer, Hughes and Strauss, 1961; Bloom, 1965, 1969; Drake, 1978; Frederickson and Mundy, 1976; Levinson, 1967; Merton, Reader and Kendall, 1957; Reissman, 1960).

This study differs from prior research in medical education in that it is a "process-outcome" study in the clinical years. There have been few studies of what actually transpires in clinical discussion groups in medical school and none of these have related the teacher or student activities to student outcomes.

Research Design

The research model used to study the research questions in this study is shown in Figure 1. The model is based on concepts of process-outcome designs suggested by Bloom (1976), Borich (1977), Smith (1975) and Winne and Marx (1977). The emphasis in this study is relating the verbal participation of the individual student to certain outcomes thought to be important to students in the clinical years of medical school.

The design shows that both the students' cognitive and affective entry characteristics as well as the teacher's verbal behavior are factors that relate to the student's verbal participation. The model suggests that:

1. there is a reciprocal influence between the teacher and the student,
2. student entering characteristics may influence outcomes directly, and
3. some measures may serve both as outcomes from one interaction and as prerequisite skills for the next learning experience.

It is obvious that the model does not provide a comprehensive framework for all the factors that impinge on the teaching/learning process. Some of the aspects that this model (and the present study) does not address are:

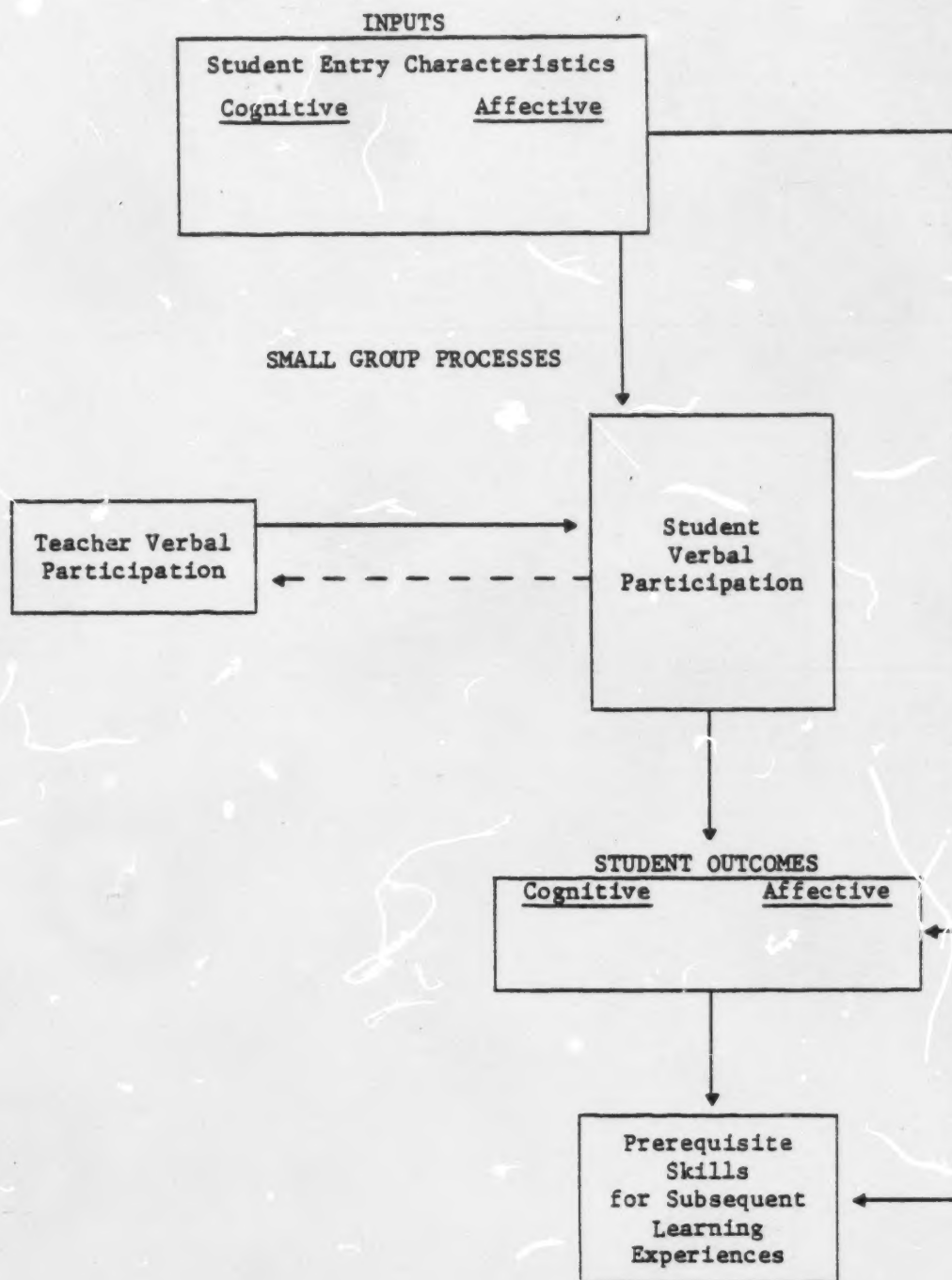


Figure 1
The Research Design

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1. Instructor input characteristics and their decision making skills. While the teacher's goals were solicited they were not entered into the computation analysis so as to obtain their specific contribution to either the processes in the student-teacher interaction or the students' outcomes.

2. The degree to which student behavior (both in and out of class) influenced the teacher's activities. This is known to be a significant factor (Klein, 1971; MacLeish and Martin, 1975; Noble and Nolan, 1976; Winne and Marx, 1977) but it was not studied in this investigation.

3. The effects of the environment on the student's verbal participation in the small groups were not studied. Spatial factors such as seating arrangements, distance from the teacher and other students might have affected the student's verbal participation. These were not studied although they are known to have some relationship (Hall, 1966; Michelini, Passalacqua, and Cusimano, 1976; Stone and Morden, 1976).

4. Covert participation in class. The overt verbal participation in a classroom or small group is probably just the "tip of the iceberg" of the total intellectual activity of the participating student. Several studies (Bloom, 1954; Krauskopf, 1963; Siegel, Capretta, Jones and Berkowitz, 1963) have attempted to investigate this "covert participation" but it is beyond the scope of this study.

Methodology

The sample consisted of 119 third-year medical students and 22 medical faculty in a private west coast university. The students had been

assigned by the dean's office to sixteen small groups of six to nine members each to discuss their patient workups. The students' entry characteristics were assessed by three cognitive and three affective input measures. The cognitive measures included an assessment of aptitude--the Medical College Admission Test (MCAT), preclinical performance--The National Board of Medical Examiners, Part 1 (NBME-1), and critical thinking--The Watson Glaser Critical Thinking Appraisal Test A (CTA-A). The affective measures were three scales from the California Psychological Inventory (CPI): Achievement via Independence, Achievement via Conformance, and Flexibility.

During one quarter of their third year, sixty-two of the small group sessions which averaged 75 minutes each in duration, were observed by the investigator. Each entire sessions was audiotaped and the teacher and each student clearly identified from photographs obtained from the dean's office and by notes made by the observer of each person who was speaking while the session was in progress. This enabled the observer to clearly identify each individual in later analyzing the audiotape. Faculty and students indicated that there was either none or minimal observer interference in the group sessions.

The observational tool for the process measures was a modified version of the Flanders System of Interaction Analysis which included support (encouragement and the use of student ideas), criticism and questions for teachers and initiation of verbal participation, and responding to the teacher for students. Both teacher questions and student discussion incorporated the cognitive levels of Bloom's taxonomy. This tool was used to code all the individual student and teacher verbal behavior at three-second intervals throughout the entire length of each of the sixty-two observed sessions.

When the investigation had been completed, the sixty-two tapes were coded in random sequence to minimize the possibility of introducing bias into the coding of the data. To test the observer's consistency in coding, six tapes were randomly selected for intrarater reliability midway through the coding of the sixty-two sessions. Five-minute samples from these six tapes were coded again and compared with the previous coding. Intrarater reliability using Cohen's kappa (Cohen, 1960) was 0.95.

When the coding of all the tapes was completed, five-minute samples from an additional twelve randomly selected tapes were used for an interrater and intrarater reliability study. For the interrater reliability the present study used a teacher familiar with the use of the Flanders System of Interaction Analysis and Bloom's taxonomy. The Cohen's kappa for interrater reliability for the twelve sessions was 0.95. The intrarater reliability for the twelve sessions was 0.98. Cohen's kappa was used as the method for measuring agreement between raters because it compares each category unit by unit rather than by total frequencies. With this method observers must agree on almost every event in order to achieve high reliability (Frick and Semmel, 1978).

One aspect of this study, seldom mentioned in other reports, is the measurement of reliability of the process variables. Reliability was determined by comparing the frequency of the process variables between the first and second halves of the time over which they were studied. Split-half reliability coefficients were obtained by the Spearman-Brown formula for each of the process variables. The average reliability for the major teacher talk variables was 0.80 and for the student talk variables was 0.76.

The higher cognitive levels of teacher questions and student discussion were more stable than the lower levels of questions and discussion. "Application" appeared to be the least stable of the cognitive levels.

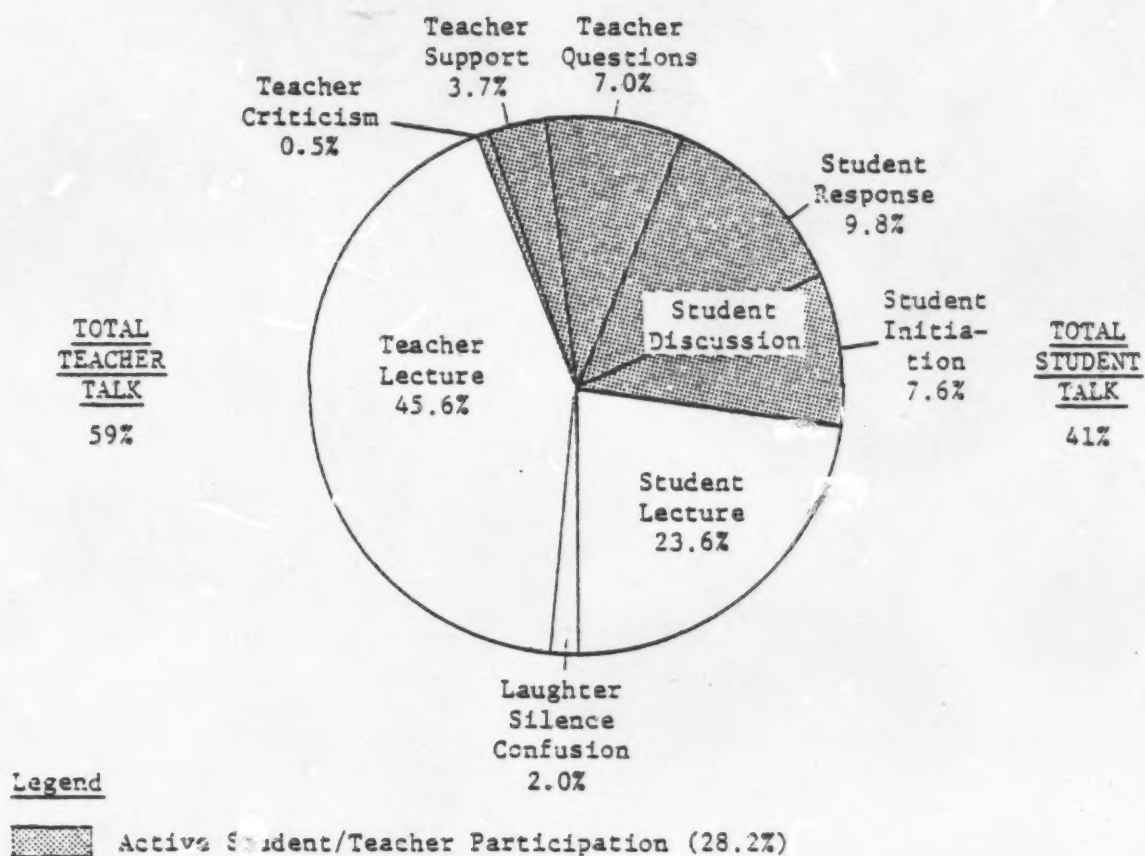
The cognitive outcome measures included the Watson Glaser Critical Thinking Appraisal Test B (CTS-B), and the preliminary ("mock boards") National Board of Medical Examiners, Part II (NBME-2).

The Statistical Package for the Social Sciences (SPSS) (Nie, et al., 1975) was used for data analysis from two "files" of the data. The "student file" consisted of the entry, process, and outcome data on each of the 119 students. The "tape file" contained the tabulated data of each participant's (teacher and student) activity during the sixty-two group sessions. These two systems of presenting the data--by student, and by small group session--afforded a more accurate analysis of what transpired than could be obtained by either system of data display alone. These data were then tabulated to give descriptive statistics. Product-moment correlations and multiple regressions analyses were performed to determine relationships between the different variables for the individual students and teachers. The analysis looked at input, process and outcome data separately and in relationship to each other.

Findings

Student and Teacher Interaction

Figure 2 shows the distribution of student and teacher verbal participation when averaged over the sixty-two group sessions. It is interesting to note that over 28 percent of the class time was spent in active teacher-student interaction.



Figure

Student and Teacher Verbal Participation for the 62
Sessions Observed as a Percentage of Total
Class Time

Contrary to reports such as Karp and Yoels (1976) which indicated that most students remained in the "silent majority" in college classes of any size, this study showed that all but four of the 119 students participated verbally in one way or another in the small groups during the quarter in which they were observed.

Table 1 presents the distribution of student talk in terms of cognitive levels. Three-fourths of all student talk (76.5%) is found at the knowledge level. While talk at the comprehension level comprises almost one-fifth (18.8%) of the discussion, higher level thinking (analysis, synthesis and evaluation) accounts for only one-fiftieth (2.0%) of the student's discussion. The amount of higher level thinking talk was variable and depended considerably on the cognitive level of the teacher's questions. In thirty-four classes no talk at higher level thinking occurred, but in ten others more than 5 percent of the class time was spent in talking at the higher cognitive levels.

Examples of teacher questions at each of the six cognitive levels are shown in Table 2. The cognitive level of the teachers' questions is presented in Table 3. Two-thirds of the teachers' questions were at the knowledge level. While 7.7 percent of the questions asked required students to use application, only 3.3 percent of the questions were at the higher levels of thinking. Teachers who asked the greatest number of higher level questions also tended to accompany these questions with "probing" statements and questions such as "What else would help us make this diagnosis?" "What other factors are important here?: "Tell me more about that." These teachers also used

Table 1
 Distribution of Student Talk by Cognitive Level
 for the 62 Sessions Observed
 N=119

Cognitive Level of Student Discussion	% of Student Discussion		Range	
	Mean	S.D.	Minimum	Maximum
Knowledge	76.5	14.0	39.0	100.0
Comprehension	18.8	11.4	0	50.0
Application	2.7	4.4	0	19.0
Higher Level Thinking	2.0	3.5	0	19.0
Analysis	1.4	3.0	0	19.0
Synthesis	0.3	0.9	0	6.0
Evaluation	0.2	1.2	0	9.0

Table 2

Examples of Medical Faculty Questions According to the
Six Levels of Bloom's Taxonomy

<u>Knowledge:</u>	What was the heart rate? Where is the primary lesion?
<u>Comprehension:</u>	When would you use that type of hernia repair? Why is the fracture in the same place it was before.
<u>Application:</u>	You are watching the patient and she falls. What would you do? Here is a lady with no vibratory sensation. What problems does that pose?
<u>Analysis:</u>	What are the most significant aspects of this patient's story? That is a curious bit of information. How do you explain it? How would you divide that information into ways of looking at it?
<u>Synthesis:</u>	How would you summarize this? What are your conclusions?
<u>evaluation:</u>	Why is that pertinent information? How valid is this patient's story?

Table 3

Cognitive Level of Teacher Questions for the 62 Sessions
Observed as a Percentage of Teacher Questions

Cognitive Level of Teacher Questions	Mean	S.D.	Range	
			Minimum	Maximum
Knowledge	67.2	12.9	37.1	100.0
Comprehension	21.8	10.5	0	42.3
Application	7.7	7.6	0	28.6
Higher Level Thinking	3.3	3.7	0	14.0
Analysis	2.1	3.1	0	12.4
Synthesis	0.7	1.2	0	4.8
Evaluation	0.4	1.0	0	6.2

more "teacher support" (encouragement and the use of student ideas) than those who asked fewer questions at these higher cognitive levels.

The teachers' support tended to be directed toward encouragement of performance and ideas rather than personal praise. Criticism was seldom used by these teachers. Usually criticism was not personal but was directed toward helping the student improve his response and look for alternatives. Typical comments of teachers included, "No, don't speculate," "Don't make unwarranted assumptions," "Be more precise," "Be more careful with the terms you are using," "When you fail to tell me something I might logically expect, I consider your presentation defective."

Table 4 shows that there was a significant relationship between the cognitive level of the teacher's questions and that of the student's response. The correlation coefficients for teacher questions and student responses at the cognitive levels of knowledge, comprehension and application were 0.3, while the correlations at the higher cognitive levels of analysis, synthesis and evaluation were more than 0.4.

Student Entry Characteristics and Verbal Participation

Correlations between the student's input characteristics and his verbal participation in the small groups showed few significant relationships. Of the 66 product moment correlations that were performed only five were significant (Table 5). These correlations were low even after they were corrected for the attenuation of both of the variables, suggesting that the underlying constructs did not show strong relationships. Correlations between the entry characteristics and the student participation variables

Table 4

Product Moment Correlations for Teacher Verbal Participation in Class
with Student Verbal Participation in Class

	Student Discussion	Student Knowledge	Student Comprehension	Student Application	Student Higher Level Thinking
Teacher Support	.3318*	-.1519	-.0287	.3627*	.2099
Teacher Criticism	.0026	-.1463	.1545	-.0956	.1992
Teacher Questions	.6179*	-.1989	.1203	.1457	.2180
Questions Knowledge	-.4115*	.3036*	-.1947	-.3641*	-.1213
Questions Comprehension	.3850*	-.3707*	.3094*	.2172	.2016
Questions Application	.0590	.0287	-.0595	.2893*	-.2802*
Questions Higher Level Thinking (Analysis, Synthesis & Evaluation)	.2302*	-.0741	-.0698	.0672	.4336*

* $p < .01$

Table 5

**Product Moment Correlations for Student Entry Characteristics and Individual
Student Verbal Participation in Small Group Sessions**

Entry Characteristics	Individual Student Verbal Participation in Small Groups					Higher Level Thinking
	Initiation	Response	Knowledge	Compre- hension	Application	Thinking
<u>Cognitive Variables</u>						
MCAT Verbal	.0769	-.0172	-.0066	.1442	-.1145	.0698
MCAT Quantitative	.0749	-.0112	-.1267	.1098	-.0743	.1013
MCAT General Information	.0498	-.0243	-.0184	.1089	-.0680	.0153
MCAT Science	.0232	.0452	.1191	-.1779	-.1103	.0924
NBME Part 1 Average	.1765 (.27)*	.0430	-.0564	-.0302	-.0916	.2118 (.33)*
Critical Thinking CTA (Test A)	.1102	.0883	.0319	.0319	-.0561	.1959 (.34)*
<u>Affective Variables</u>						
CPI Achievement via Independence	-.0651	-.0371	.0414	-.0981	-.0353	.0727
CPI Achievement via Conformance	.0641	-.0031	.1032	-.1150	-.0243	.0995
CPI Flexibility	.1989 (.37)*	.0338	-.0455	-.0052	-.0250	.1802 (.34)*
Attitude Toward Continuing Education	.0402	-.0982	.1570	-.1179	-.1241	.0490
Attitude Toward Research	-.0186	.0466	-.0077	.0626	-.0348	.1455

* $p < .01$

Correlations in parentheses corrected for attenuation of both variables.

showed that the NBME-1 and CPI Flexibility correlated with the students' initiation of verbal activity ($r=0.27$, $r=0.37$), and higher level thinking ($r=0.33$, $r=0.34$).

The interrelationship of the entry characteristics with the amount and cognitive level of verbal participation of the students in the sessions was determined by multiple regression analysis and is shown in summary in Table 6. The amount of student discussion would not be predicted from any of the students' entry characteristics. Flexibility (CPI Fx) was a significant predictor of the individual student initiated talk but accounted for less than 4 percent of the variance. Three input variables, the NBME-1, CTA-A and the CPI Fx accounted for almost 10 percent of the variance in the higher cognitive levels of verbal expression.

Verbal Participation and Outcomes

Product moment correlations between the individual student's verbal participation and the outcome measures are shown in Table 7. It is noted that student verbal participation at the higher cognitive levels was significantly correlated with their scores on the National Board of Medical Examiners Part 2 (NBME-2) and the Critical Thinking Appraisal Test B (CTA-B).

Multiple regression analyses were also performed for each of the outcome measures. The hierarchical method for the inclusion of independent variables (Cohen and Cohen, 1975) was utilized with the entry measures entered first into the regression. Verbal participation variables were entered last into the regression in order to determine whether or not these variables would still account for any variance in the outcome measure when the student's entry characteristics had been considered. The process

Table 6

Summary of Significant Findings for Multiple Regressions of
Individual Student Verbal Participation in Class
with Cognitive and Affective Entry Measures

Individual Student Verbal Participation Variables	Significant Predictors	% Variance Accounted for by Variable	F for Variable
Individual Response	No significant predictors	-	-
Individual Initiation	CPI Flexibility	3.9	4.05**
Individual Knowledge	No significant predictors	-	-
Individual Comprehension	No significant predictors	-	-
Individual Application	No significant predictors	-	-
Individual Higher Level Thinking	NBME Part I Average	4.5	3.9**
	Critical Thinking (CTA-Test A)	2.9	2.4*
	CPI Flexibility	2.1	2.9*

* $p < .05$

** $p < .01$

Table 7

Product-Moment Correlations for Individual Student Verbal
Participation in Small Group Sessions
and Outcome Measures
(n=109)

Individual Student Verbal Participation	Outcome Measures				
	NBME-2	CTA-B Critical Thinking	Attitude Toward Continuing Education	Attitude Toward Research	Satisfaction (n=104)
Student Discussion	.0475	.0820	.0550	.1359	.1658
Student Initiation	.0630	.0922	-.0260	.0746	-.0238
Student Knowledge	-.0604	.0713	.0623	.0161	.0762
Student Comprehension	-.0712	-.0715	.0804	.1520	-.0217
Student Application	.1388	.1650	-.0830	-.0908	.0099
Student Higher Level Thinking	.1994* (.30)***	.2364** (.36)**	.1094	-.0006	.0905

*p<.05

**p<.01

*Scores in parentheses corrected for attenuation.

variables which had been found to be "unstable" (individual application and comprehension) were not entered into the regressions for the analysis because findings derived from unstable variables are likely to be spurious. The multiple regression analyses show that entry characteristics had a far larger relationship to outcome measures than did the process or talk variables. While there were significant correlations between some aspects of verbal participation and outcome measures, e.g., higher level thinking talk with the critical thinking test (CTA-B), the multiple regression analyses "partialled out" practically all of the variance to the entry characteristics leaving verbal participation with no significant contribution to any of the outcome measures (Table 8).

Table 8

Summary of Findings for Multiple Regressions of Individual
Student Verbal Participation in Small Groups
with Entry, Outcome and Process Measures
(n=109)

Outcome Measures	Significant Predictors	R ² Change	F for Variable
NBME Part II Average	NBME Part I Average	.536	97.1
	MCAT General Information	.030	5.1
	Higher Level Thinking	.006	1.4
Critical Thinking Appraisal (CTA Test B)	Critical Thinking (CTA Test A)	.241	17.6
	CPI Achievement via conformance	.050	4.5
	Higher Level Thinking	.002	0.3

Discussion

Two major results have emerged from this study. The first is that the cognitive level of the teacher's questions is significantly correlated with the cognitive level of the individual student's response--particularly at the higher cognitive levels of analysis, synthesis and evaluation. These findings show that teacher verbal behavior can significantly influence the student's overt participation in clinical discussion groups. This presumably increases the student's "covert" participation as well, but this was not measured in this study.

The second major finding is that while there were significant correlations between some aspects of verbal participation and outcome measures, the student's entry characteristics had a far larger effect on outcome measures than did the process or talk variables in the small discussion groups. The findings in this study indicate that student verbal participation variables in themselves contributed little to the particular outcome measures. This does not necessarily mean that processes are unimportant, but in the design of the present study they contributed a very small amount to the total variance of these particular outcome measures.

There are several factors that may relate to this apparent lack of influence of the "process" on the "outcomes" in this study. One is the variability of the "processes" within the sample over the relatively short observation period. Another possible factor was that the discussion groups were a relatively small portion of the student's academic activities. While

other activities may have had more relationship to the student's cognitive outcomes than the small group discussions, one would assume that their behavior as measured in the small groups was qualitatively similar to that in their other activities. It is always possible that other tools or analytic formulae may more accurately describe the relationships involved, but one could only speculate on their results.

There was little relationship between the students' cognitive outcomes and their verbal participation. Since these case presentation groups are "expensive" of teacher time, one might question the value of these small group discussions. Of interest is the observation that student satisfaction with the small discussion groups was high. Over 89 percent of the students stated that the clinical discussion groups "were a valuable part of their third year" of medical education. The ability to associate closely with good role models, who showed them how clinical reasoning is done and how patients' problems can be solved, probably had an influence beyond that of the specific outcomes measured in this study.

This is a one-group, single-institution sample. The extent to which the findings in this study can be generalized is unknown. For similar medical schools the expectations are that the outcomes would be similar, but to generalize the relationships described in this study, there would need to be cross validation in other medical school settings.

Caution is urged in the indiscriminate application of the findings of this study. Since this and other studies have shown that teachers can stimulate more higher level thinking talk by students, the teacher might

be encouraged to purposefully use these skills to facilitate more student participation at the higher cognitive levels. Faculty developers who encourage this activity as one of their goals, should work closely with those in educational research to see whether the skills they are encouraging will result in measurable improvement in student performance.

Summary

This study looked at several aspects of clinical instruction to 119 medical students in sixty-two small group sessions. These included the amount and cognitive level of teacher questioning and student discussion and documented how certain student cognitive outcomes are related to them. Drawing from the actual transcripts of over 75 hours in small group sessions, the study examined in detail how much the "process" of the small group interaction related to selected outcomes such as the student's ability to think critically and their performance on National Board of Medical Examiners examinations. The instrument used for teaching analysis was a modified version of the Flanders System of Interaction Analysis which incorporated Bloom's Taxonomy of the Cognitive Domain.

The cognitive level of the teacher's questions had a significant relationship to the cognitive level of the students' responses and discussion. While there were significant correlations between some aspects of verbal participation and outcome measures, the multiple regression analyses showed that classroom activity contributed little to outcomes. The major contributions to outcomes were the aptitude and previous knowledge that the students already possessed.

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